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(54) Bandwidth and congestion management in accessing broadband ISDN networks

Bandbreitenverwaltung und Überlastabwehr für den Zugang zu Breitband-ISDN-Netzen

Gestion de la bande passante et de la congestion pour l'accès à des réseaux à intégration de services à large bande

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EP 0 487 235 B1

Description

[0001] This invention relates to methods of and apparatus for throttling input to a data network.

[0002] Telecommunications networks can be organized to set up circuit connections between end terminals or to set up connections such as packet switched connections which are typically characterized by transmitting signals at a variable rate. When the network only establishes circuit connections, the decision on access to the network is relatively straightforward: if a circuit is available to the destination, a connection may be set up and if no such circuit is available no connection is set up. When a variable bit rate connection is requested, the situation is much more complex. The network depends on the statistics of input traffic and on intermediate buffering to ensure that all of the signals transmitted between terminals, including computer workstations, connected to the network can in fact be so transmitted. Signals are transmitted over "virtual channels" for interconnecting data sources and destinations which are used only when signals are actually to be transmitted, thus making the physical channels available to other virtual channels when no signals are being transmitted. In particular, for a broadband network, such as a broadband Integrated Services Digital Network (B-ISDN) to which is attached a large number of broadband terminals, each of which can generate signals of high bandwidth for its virtual channels, the potential signal traffic of all virtual channels which may at one time be connected to the network in an active state can far exceed the capability of the network to transmit such signals.

[0003] The data transmission protocol within a broadband ISDN is Asynchronous Transfer Mode (ATM) which utilizes short fixed length data cells. These cells then form the basic atomic unit for the transmission of signals within a broadband ISDN. A frame, a basic unit for packet data transmission, is transported across the broadband ISDN by segmenting it into a plurality (not necessarily an integral number) of short fixed length data cells and transporting those cells across the network. The B-ISDN network accepts signals at a STS-3C rate of 155.52 megabits per second (Mb/s). Terminals connected to such a network may generate signals to transmit or receive at a 155.52 Mb/s rate. It is characteristic of the virtual channels of many of the terminal devices connected to a broadband ISDN network that they do not continuously generate traffic at their peak data rates. In other words, the terminal output tends to be bursty. For a B-ISDN network, if all virtual channels were to generate bursts simultaneously, the instantaneous bandwidth could far exceed the output bandwidth of the network. The broadband network can take advantage of the statistical nature of this burstiness to accept and process traffic whose instantaneous peak could far exceed the capacity of the network. However, there is at present no good way to allow access to the network by virtual channels whose combined peak bandwidth is in excess of the basic input bandwidth allowed by the network.

[0004] In the prior art, it has been proposed that access to a network be provided by dedicating bandwidth to each of the terminals requesting such bandwidth and limiting this dedicated bandwidth to the output bandwidth of the network. Such a scheme while protecting the network from overload, tends to sharply underutilize the capabilities of the network since advantage cannot be taken of the short term statistical variations of the input traffic. In other words, such a network is engineered to the peak bandwidth requirement.

[0005] Another prior art solution is the flow/congestion control scheme of the Consultative Committee for International Telephone and Telegraph (CCITT) X.25 standard. This arrangement permits a specifiable number of data entities (packets) to be transmitted before an acknowledgment must be returned; the acknowledgment message can be delayed to reduce data traffic. Further, X.25 receivers can send an explicit request to turn down packet traffic via a "Receiver not ready" message. Such an arrangement responds to peaks of traffic slowly, restores normal operation slowly, and requires that the network terminate traffic above layer 1.

[0006] Accordingly, in the prior art there is no efficient arrangement available for avoiding network overload to a broadband variable bit network while retaining the efficient utilization of the network and the input terminals to that network.

[0007] F. Dennissen, et al.: The Policing Function in an ATM Network, 1990 International Zurich Seminar on Digital Communications, March 5-8, 1990, Proceedings IEEE 1990 THO305-3 discloses a data network connected to a plurality of data terminals. The network is an ATM Network which uses virtual channels. The input to the network is throttled through the use of a policing function to insure that terminals are not generating traffic beyond the allowed parameters of their respective virtual channels.

[0008] M. Gerla and L. Kleinrock: Congestion Control in Interconnected LANs, IEEE Network, January 1988, Vol. 2, No. 1, discloses an arrangement for throttling the input to a network of interconnected LANs by detecting overloads for particular channels and informing the sources of such overloads by the use of "choke" packets or by applying "backpressure" in order to reduce the transmission rate of one or more sources sharing a link.

[0009] According to one aspect of this invention there is provided a method as claimed in claim 1.

[0010] According to another aspect of this invention there is provided apparatus as claimed in claim 10.

[0011] In an embodiment of the invention, when the network detects temporary overload, the network transmits slowdown messages to connected virtual channels to further shape the rate of transmission of signals by temporarily substituting tighter values of the emission control parameters. In one exemplary embodiment, such slowdown messages are sent with a high level of priority so that they can be received very quickly by the

sources of traffic. Such slowdown messages may either have permanent effect until a resume message is received; have temporary effect and require a repeat of the slowdown message to be effective for more than one interval; or specify the number of intervals to be covered before automatically resuming the normal transmission in the absence of another slowdown message. These signals are conveyed by layer 1 and do not require the network to terminate higher layers of protocol in order to provide background flow/congestion control.

[0012] A call from a terminal is defined by a virtual channel and its associated plurality of bandwidth emission control parameters; the peak bursts of traffic from such a terminal are then shaped by these parameters. Advantageously, in accepting such a call, the network input received from that terminal is limited by these parameters. In accordance with one specific implementation of the invention, the virtual channel emission control parameters include a first parameter which defines the number of cells which a terminal may not use between any pair of cells conveying data from that terminal, a second emission control parameter limiting the number of cells which may be transmitted in an interval, and a third parameter specifying the length of the interval. In one specific implementation, this interval is 6 milliseconds and is the same interval for all terminals connected to the network. The network will consider a request from the terminal for a connection with prespecified parameters and accept or deny the request according to whether sufficient capacity is available. The network may negotiate with the terminal concerning the parameters by providing an alternate lower value for the virtual channel emission control parameters for a specific call. In other implementations, the terminal may simply retry with the same or different values of emission control parameters after receiving a rejection.

[0013] The terminal equipment is typically not under the control of the provider of the broadband network services. Therefore, it is necessary to find arrangements for enforcing the limits which have been prespecified to and by the terminal when the call was accepted. Each virtual channel may be monitored to ensure that the virtual channel bandwidth emission control parameters for that virtual channel for that call are not exceeded. This process of monitoring traffic is combinable with the process for determining charges for the use of the broadband network. The process is also required since customers are likely to be charged for the virtual channel bandwidth that they have requested or been assigned for a call so that it is important that arrangements are available to detect if they are in fact transmitting at a higher rate. The number of cells transmitted per unit interval may be averaged over a longer interval in the policing process in order to account for jitter (e.g., due to multiplexing devices on customer premises causing variable delay for ATM cells of the same virtual channel) at the input to the broadband network. The policing could be done only on the bandwidth emission control parameter that limits the number of cells per 6 milliseconds since this is the parameter that controls the bandwidth.

[0014] The intercell spacing parameter limits spacing between cells on a particular virtual channel. The intercell spacing parameter allows the broadband network to operate more efficiently and to reduce collisions between cells from several interfaces that are to be transmitted on a single outgoing interface.

[0015] In another embodiment of the invention, a peak rate and an average rate of transmission of data cells is specified for a virtual channel. The virtual channel generates data cells at a rate limited to the average rate, and restricted to the specified peak rate. The peak rate, which for a leaky bucket is the fill rate, is tied to the minimum intercell spacing. The average rate is determine by the drain rate of a leaky bucket, the size of the leaky bucket being used as a third flow control parameter.

Brief Description of the Drawing

[0016]

FIG. 1 is a block diagram of an exemplary data network and messages exchanged between units to implement the invention; and

FIGS. 2-4 are flow diagrams of actions required to implement the invention in the network of FIG. 1.

Detailed Description

[0017] A plurality of data sources, typically terminals, are connected to the ports of a broadband ISDN network usually through a network termination device. The higher speed terminals that are connectable to a B-ISDN network must, in general be capable of controlling the rate at which they transmit data signals to the B-ISDN network. For terminals which are incapable of varying this rate, it is necessary to establish the equivalent of a circuit connection through the B-ISDN network wherein a steady flow of signals at the data rate of the sending terminal can be guaranteed. For terminals which can control their rate of data generation, and it is these types of terminals to which the principles of the present invention apply, it is necessary to restrict the rate at which data signals for conversion into cells are generated. This restriction takes two forms: a very short term restriction determined by the intercell spacing and a short term restriction determined by the maximum number of cells in one interval. The very short term restriction ensures that successive cells from data of a given terminal, transmitting over a given virtual channel, are generated with a minimum intercell interval. If necessary, this minimum intercell interval is enforced by transmitting empty cells from the terminal, but successive active cells from a given terminal for a given virtual channel are limited to a spacing that is a basic parameter of a particular call connection between that terminal and a destination. The short term limitation is a limitation on the number of cells

for which signals may be generated by the terminal during a prespecified interval, or the long term average number of cells per second. The typical such prespecified interval is 6 milliseconds, a number which could be standard throughout the B-ISDN network. However, it is possible to use different limits in different parts of the network and/or to use different limits for different kinds of terminals. For example, for a device such as a video signal generator, whose average data rate is typically uncontrollable or controllable only in a small number of different steps, the predetermined interval may be determined more by the size of the receive buffer for assembling the video signals. The 6 millisecond figure is selected to match the size of storage available in nodes of the B-ISDN network; 6 milliseconds is the intercell time for a 64 kilobit per second virtual channel. A larger or smaller interval would be used for different amounts of network storage.

[0018] Alternatively, a leaky bucket arrangement provides added flexibility by permitting up to a peak rate to be sustained until the bucket is full, then limiting the rate while the bucket is full to the drain rate of the bucket. With a leaky bucket arrangement, augmented by a fill rate limiter, the three parameters are the intercell spacing (peak rate), drain rate (average rate), and size of the bucket (controls averaging interval).

[0019] The choice of the virtual channel(s) whose output is to be limited may be made in a number of different ways. If a priority scheme is in use, lower priority virtual channels are preferred candidates. High bandwidth virtual channels are also preferred candidates. Active virtual channels are preferred candidates since little is gained by reducing the output bandwidth of inactive virtual channels. Channels which have cells queued up in internal buffers are preferred candidates because these cells are actually the cells causing a congestion buildup. Any virtual channel which has been exceeding its allotted average bandwidth for a substantial times is a preferred candidate. When congestion is discovered, enough bandwidth reduction from enough virtual channels must be achieved to remove the congestion.

[0020] FIG. 1 is a block diagram showing terminal equipment 1 and 2 connected to a network termination 3 which in turn is connected to a network switch 4 that is part of a broadband data network 20. The terminal equipment (such as TE1, TE2) sends a request for the establishment of a virtual channel to a specified destination and requests that the virtual channel be characterized by a cell rate of no more than one cell for every N1, which need not be an integer, cells transmitted from TE1 and no more than N2 cells transmitted over that virtual channel per 6 milliseconds. This information is conveyed in a single or multiple cell message 10 sent from terminal equipment 1 to the network switch 4. In response, the network switch 4 sends back the message 11 identified by the number of the virtual channel with an accept/reject indication and any additional parameters required, such as a retry time for a reject message. The terminal equipment, such as TE1 is controlled by a processor 7, operative under the control of a program within the processor 7. Network switch 4 is controlled by a processor 5, operative under the control of a processor within processor 5.

[0021] In alternative embodiments, the network terminal sends not just a rejection but an acceptable value of N1 and N2 in case the levels requested by the terminal equipment for that virtual channel are too high. A simple accept/reject has the advantage that the responsibility for trying an alternate value of N1 and N2 rests with the terminal equipment which may not be able to use lower values and for which it would be better simply to wait and try again. Also, with the accept/reject arrangement it is not necessary for the network termination equipment to reserve the bandwidth associated with the offered alternative. If a request to set up the virtual channel is rejected, no resources need to be set aside.

[0022] If the virtual channel has been set up and it is now necessary to throttle the rate of active cells being submitted to B-ISDN network 20 at the ingress network switch 4, this switch sends a load reduction request message 8, including load reduction parameters to the network terminal. This is a request to reduce the rate of cells for a predefined period or to specify lower leaky bucket fill, drain, and size parameters. The load reduction request is forwarded from the B-ISDN network 20, via the network termination 3, to terminal equipment 1. The load reduction request message has the effect of increasing the N1 factor and decreasing the N2 factor by a predetermined schedule, or by parameters of the message.

[0023] Following the lapse of that period, normal traffic levels are resumed unless in the meantime a new load reduction request message has been received. Alternatively, the length of the period may be specified in the message. Alternatively, load resumption messages are required to turn off the effect of a load reduction request so that the load reduction request remains in force until a resumption message is received. The latter arrangement has the advantage of enforcing a positive signal as a means of turning off the load reduction, but has the disadvantage that if the resumption message is lost, the load reduction remains in effect longer, until a timeout interval has elapsed.

[0024] FIG. 2 is a flow diagram of actions performed to implement the invention. The actions are performed in program-controlled processor 5 of the network switch, and program-controlled processor 7 of the terminal. A request message is received in the network switch from a terminal (action block 202). The network switch checks whether the request can be accepted (test 204). The test is made taking into account the present load leaving the network termination and the load that the network switch will accept at this time. If an additional virtual channel with the bandwidth parameters specified in the request message can be accepted (positive result of test 204), then an accept message is transmitted back

to the terminal (action block 206) and actions are taken to setup a virtual channel from the terminal (action block 208). If the result of test 204 is negative, a further test is made whether a reduced bandwidth virtual channel can be accepted or whether the request should be totally rejected. A reduced bandwidth virtual channel can be accepted if substantial additional load, although less than the requested load, can be accepted. If the result of test 210 is negative, then a reject message is sent to the terminal (action block 212) and the terminal notifies the user of the overload (action block 214). If a reduced bandwidth virtual channel can be accepted, then a message is transmitted from the network switch to the terminal to indicate the reduced bandwidth parameters for an acceptable virtual channel (action block 216). The terminal tests whether this reduced bandwidth is adequate (test 218) and if so performs the actions for setting up a virtual channel (action block 208). If the reduced bandwidth is inadequate, the connection is rejected by the terminal and the user is notified of the overload (action block 214).

[0025] FIG. 3 is a flow diagram of the process of monitoring and the actions taken when a virtual channel transmits at a rate in excess of the rate specified by the parameters for that virtual channel. The rate of transmission is monitored (action block 302) by the transmission process. This is performed in network switch 4. If a virtual channel exceeds its allowed transmission rate as determined by the parameters for that virtual channel, then this excess is detected (action block 304). In response to this detection, a slow down message is sent to the terminal transmitting for that virtual channel (action block 306), the slow down message having parameters for a lower bandwidth transmission rate. In the meantime, excess cells are dropped or tagged for potential dropping. If, sometime thereafter, a continued excess transmission rate exists on that virtual channel, as detected in action block 308, then the virtual channel is disconnected (action block 310). The disconnection may be preceded by a warning message to give the terminal controlling the virtual channel an opportunity to limit the transmission rate.

[0026] FIG. 4 is a flow diagram of actions performed in response to overload. Overload is detected in the network switch (action block 400). If overload is detected in the network switch, virtual channels are selected for slow down (action block 404). Slow down messages for these virtual channels are transmitted to the terminals serving these virtual channels (action block 406). If, after the elapse of time, a continued overload exists as detected in test 408, the process of selecting virtual channels for slow down (action block 404) and the transmission of slow down messages (action block 406) to these virtual channels is continued. These actions are also performed in response to the detection of continued overload in the network termination. After the overload disappears, normal operation is resumed by letting the timing of the slow down messages lapse so that the effect of the slow down messages disappears. If slow down messages are used which do not have a time but which are indefinite, then messages to undo the slow down messages must be sent (process not shown).

[0027] It is to be understood that the above description is only of one preferred embodiment of the invention. Numerous other arrangements may be devised by one skilled in the art without departing from the scope of the invention. The invention is thus limited only as defined in the accompanying claims.

Claims

1. A method of throttling input to a data network (20) connected via an ingress switch (4) to a plurality of data terminals (1,2), each terminal being for serving at least one virtual channel, said ingress switch having a capability for serving a maximum data traffic load from said data terminals and from said network, comprising the steps of:

   detecting (400) in said ingress switch of said data network that a load submitted from said data terminals and from said network exceeds said maximum data traffic load; and

   CHARACTERISED BY:

   responsive to said detecting, selectively (404) transmitting (406) slow down messages (9) for changing at least one parameter, said at least one parameter being used for controlling the rate of transmission of data over a virtual channel, in a direction to reduce said rate of transmission to said ingress switch of said network from ones of said virtual channels;
   wherein selectively transmitting comprises selecting virtual channels whose data rate is to be reduced by considering at least one of priority (low priority preferred), bandwidth (high bandwidth preferred), and usage (channels exceeding their bandwidth allotted data rate preferred) of each candidate virtual channel.

2. A method as claimed in claim 1 wherein if, after the lapse of an interval of time, the submitted load continues to exceed said maximum data traffic load, the step of selectively transmitting slowdown messages is repeated.

3. A method as claimed in claim 1 or 2, comprising:

   in one of said virtual channels, responsive to reception of a slow down message, decreasing a limit on a peak rate of transmission of data on said one virtual channel.

4. A method as claimed in claim 3 wherein said network is a broadband data network, transmitting data in cells, and said step of decreasing comprises decreasing a number of cells that may be transmitted per unit time from said terminal.

5. A method as claimed in claim 1,2,3 or 4 wherein said network supports priority message service, and said step of selectively transmitting comprises selectively transmitting slow down messages at a high priority level.

6. A method as claimed in any preceding claim wherein ones of said virtual channels are assigned transmission rate parameters for limiting a rate of transmission from said ones of said virtual channels, and comprising monitoring a rate of transmission from said ones of said virtual channels.

7. A method as claimed in any preceding claim comprising:

in one of said virtual channels, responsive to reception of a slow down message, deceasing a limit on an average rate of transmission of data by said one virtual channel wherein said limit is specified by providing a leaky bucket drain rate parameter.

8. A method as claimed in any preceding claim comprising the steps of:

responsive to receiving a request message for transmission from a virtual channel to said network, said request comprising at least one requested bandwidth parameter, determining whether said request can be accommodated without overloading said network; and
responsive to determining that said request cannot be accommodated without overloading said network, transmitting to said virtual channel a response message comprising at least one bandwidth parameter for a bandwidth lower than a bandwidth for said at least one bandwidth parameter received in said request message.

9. A method as claimed in any preceding claim comprising the steps of:

responsive to receiving a request message for transmission from a virtual channel, said request comprising at least one requested bandwidth parameter, determining whether said request can be accommodated without overloading said network; and
responsive to determining that said request cannot be accommodated without overloading said network, transmitting to said virtual channel a reject response message.

10. Apparatus in a data network (20) connected via an ingress switch (4) to a plurality of data terminals (1,2) each for serving at least one virtual channel, said ingress switch having a capability of serving a maximum data traffic load from said data terminals and from said network, said apparatus being for throttling input to the network and comprising:

processor means (5), operative under the control of a program, for detecting (400) in said ingress switch of said data network that a load submitted from said data terminals and from said network exceeds said maximum data traffic load;

CHARACTERISED BY:

responsive to said detecting, said processor means under the control of a program for selectively (404) transmitting (406) slow down messages (9), being for changing at least one parameter, used for controlling the rate of transmission of data over a virtual channel, in a direction to reduce said rate of transmission, to ones of said virtual channels;
wherein said selectively transmitting comprises selecting virtual channels whose data rate is to be reduced by considering at least one of priority (low priority preferred), bandwidth (high bandwidth preferred), and usage (channels exceeding their bandwidth allotted data rate preferred) of each candidate virtual channel.

11. Apparatus as claimed in claim 10 wherein if, after the lapse of an interval of time, the submitted load continues to exceed said maximum traffic load, said processor means are under the control of a program for further selectively transmitting slow down messages.

12. Apparatus as claimed in claim 10 or 11 wherein said network supports priority message service, and said selectively transmitting comprises selectively transmitting slow down messages at a high priority level.

13. Apparatus as claimed in claim 10,11 or 12 wherein said network is a broadband data network, transmitting data in cells, and said selectively transmitting high priority messages comprises transmitting said high priority messages as groups of high priority cells.

14. Apparatus as claimed in claim 10,11,12 or 13 wherein ones of said virtual channels are assigned

transmission rate parameters for limiting a rate of transmission from said ones of said virtual channels, and comprising process means, operative under the control of a program, for monitoring a rate of transmission from said ones of said virtual channels.

15. Apparatus as claimed in any one of claims 10 to 14 comprising:

processor means, operative under the control of a program, responsive to receiving a request message for transmission from a virtual channel to said network, said request comprising at least one requested bandwidth parameter, for determining whether said request can be accommodated without overloading said network; and

processor means, operative under the control of a program, responsive to said means for determining, determining that said request cannot be accommodated without overloading said network, for transmitting to said virtual channel a response message comprising at least one bandwidth parameter for a bandwidth lower than a bandwidth for said at least one bandwidth parameter received in said request message.

16. Apparatus as claimed in any one of claims 10 to 15 comprising:

processor means, operative under the control of a program, responsive to receiving a request message for transmission from a virtual channel, said request comprising at least one requested bandwidth parameter, for determining whether said request can be accommodated without overloading said network: and

processor means, operative under the control of a program, responsive to a determination that said request cannot be accommodated without overloading said network, for transmitting to said virtual channel a reject response message.

Patentansprüche

1. Verfahren zum Drosseln der Eingabe in ein Datennetz (20), das über eine Eintrittsvermittlung (4) mit einer Mehrzahl von Datenendgeräten (1, 2) verbunden ist, wobei jedes Endgerät zur Bedienung von mindestens einem virtuellen Kanal dient, wobei die besagte Eintrittsvermittlung eine Fähigkeit zum Bedienen einer maximalen Datenverkehrslast aus den besagten Datenendgeräten und aus dem besagten Netz aufweist, mit folgenden Schritten:

Erkennen (400) in der besagten Eintrittsvermittlung des besagten Datennetzes, daß eine aus den besagten Datenendgeräten und aus dem besagten Netz übergebene Last die besagte maximale Datenverkehrslast überschreitet; und gekennzeichnet durch:

als Reaktion auf die besagte Erkennung, gezieltes (404) Übertragen (406) von Geschwindigkeitsverringerungsmeldungen (9) zum Verändern von mindestens einem Parameter, wobei der besagte mindestens eine Parameter zur Steuerung der Übertragungsrate von Daten über einen virtuellen Kanal benutzt wird, in einer Richtung zur Verringerung der besagten Übertragungsrate zur besagten Eintrittsvermittlung des besagten Netzes aus jeweiligen der besagten virtuellen Kanäle;

wobei das gezielte Übertragen das Auswählen von virtuellen Kanälen umfaßt, deren Datenrate zu verringern ist, unter Inbetrachtziehung von mindestens einem der folgenden: Priorität (niedrige Priorität bevorzugt), Bandbreite (große Bandbreite bevorzugt) und Nutzung (Kanäle, die die für ihre Bandbreite zugeteilte Datenrate überschreiten, bevorzugt) jedes in Frage kommenden virtuellen Kanals.

2. Verfahren nach Anspruch 1, wobei, wenn nach Ablauf einer Zeitdauer die übergebene Last weiterhin die besagte maximale Datenverkehrslast überschreitet, der Schritt des gezielten Übertragens von Geschwindigkeitsverringerungsmeldungen wiederholt wird.

3. Verfahren nach Anspruch 1 oder 2, mit folgendem:

in einem der besagten virtuellen Kanäle, als Reaktion auf den Empfang einer Geschwindigkeitsverringerungsmeldung, Verringern einer Begrenzung einer Spitzenübertragungsrate von Daten auf dem besagten einen virtuellen Kanal.

4. Verfahren nach Anspruch 3, wobei das besagte Netz ein Breitband-Datennetz ist, das Daten in Zellen überträgt, und der besagte Schritt des Verringerns das Verringern einer Anzahl von Zellen umfaßt, die pro Zeiteinheit aus dem besagten Endgerät übertragen werden können.

5. Verfahren nach Anspruch 1, 2, 3 oder 4, wobei das besagte Netz Prioritätsmeldungsdienst unterstützt und der besagte Schritt des gezielten Übertragens das gezielte Übertragen von Geschwindigkeitsverringerungsmeldungen auf einer Stufe hoher Priorität umfaßt.

6. Verfahren nach einem beliebigen vorhergehenden

Anspruch, wobei den jeweiligen der besagten virtuellen Kanäle Übertragungsratenparameter zur Begrenzung einer Übertragungsrate aus besagten jeweiligen der besagten virtuellen Kanäle zugewiesen werden und das die Überwachung einer Übertragungsrate aus besagten jeweiligen der besagten virtuellen Kanäle umfaßt.

7. Verfahren nach einem beliebigen vorhergehenden Anspruch, mit folgendem:

in einem der besagten virtuellen Kanäle, als Reaktion auf den Empfang einer Geschwindigkeitsverringerungsmeldung, Verringern einer Begrenzung einer Durchschnitts-Übertragungsrate von Daten durch den besagten einen virtuellen Kanal, wobei die besagte Begrenzung durch Bereitstellung eines Parameters der Abflußrate eines löchrigen Eimers angegeben wird.

8. Verfahren nach einem beliebigen vorhergehenden Anspruch, mit folgenden Schritten:

als Reaktion auf den Empfang einer Anforderungsmeldung zur Übertragung aus einem virtuellen Kanal zum besagten Netz, wobei die besagte Anforderung mindestens einen angeforderten Bandbreitenparameter umfaßt, Bestimmen, ob der besagten Anforderung ohne Überladen des besagten Netzes genügt werden kann; und
als Reaktion auf die Bestimmung, daß der besagten Anforderung nicht ohne Überladen des besagten Netzes genügt werden kann, Übertragen zum besagten virtuellen Kanal einer Antwortmeldung mit mindestens einem Bandbreitenparameter für eine niedrigere Bandbreite als eine Bandbreite für den in der besagten Anforderungsmeldung empfangenen mindestens einen Bandbreitenparameter.

9. Verfahren nach einem beliebigen vorhergehenden Anspruch, mit folgenden Schritten:

als Reaktion auf den Empfang einer Anforderungsmeldung zur Übertragung aus einem virtuellen Kanal, wobei die besagte Anforderung mindestens einen angeforderten Bandbreitenparameter umfaßt, Bestimmen, ob der besagten Anforderung ohne Überladen des besagten Netzes genügt werden kann; und
als Reaktion auf die Bestimmung, daß der besagten Anforderung nicht ohne Überladen des besagten Netzes genügt werden kann, Übertragen einer Abweisungsantwortmeldung zum besagten virtuellen Kanal.

10. Vorrichtung in einem Datennetz (20), das über eine Eintrittsvermittlung (4) mit einer Mehrzahl von Datenendgeräten (1, 2) verbrunden ist, die jeweils der Bedienung von mindestens einem virtuellen Kanal dienen, wobei die besagte Eintrittsvermittlung eine Fähigkeit zum Bedienen einer maximalen Datenverkehrslast aus den besagten Datenendgeräten und aus dem besagten Netz aufweist, wobei die besagte Vorrichtung zum Drosseln der Eingabe in das Netz bestimmt ist und folgendes umfaßt:

ein unter der Steuerung eines Programms wirksames Prozessormittel (5) zum Erkennen (400) in der besagten Eintrittsvermittlung des besagten Datennetzes, daß eine aus den besagten Datenendgeräten und dem besagten Netz übergebene Last die besagte maximale Datenverkehrslast überschreitet;

dadurch gekennzeichnet, daß:

als Reaktion auf das besagte Erkennen, das besagte Prozessormittel unter der Steuerung eines Programms zum gezielten (404) Übertragen (406) von Geschwindigkeitsverringerungsmeldungen (9) zum Verändern von mindestens einem Parameter, zum Steuern der Übertragungsrate von Daten über einen virtuellen Kanal in einer Richtung zur Verringerung der besagten Übertragungsrate zu jeweiligen der besagten virtuellen Kanäle benutzt wird;
wobei das besagte gezielte Übertragen das Auswählen von virtuellen Kanälen umfaßt, deren Datenrate zu verringern ist, unter Inbetrachtziehung von mindestens einem der folgenden: Priorität (niedrige Priorität bevorzugt), Bandbreite (große Bandbreite bevorzugt) und Nutzung (Kanäle, die die für ihre Bandbreite zugeteilte Datenrate überschreiten, bevorzugt) jedes in Frage kommenden virtuellen Kanals.

11. Vorrichtung nach Anspruch 10, wobei, wenn nach Ablauf einer Zeitdauer die übergebene Last weiterhin die besagte maximale Verkehrslast überschreitet, die besagten Prozessormittel der Steuerung eines Programms zum weiteren gezielten Übertragen von Geschwindigkeitsverringerungsmeldungen unterliegen.

12. Vorrichtung nach Anspruch 10 oder 11, wobei das besagte Netz Prioritätsmeldungsdienst unterstützt und das besagte gezielte Übertragen das gezielte Übertragen von Geschwindigkeitsverringerungsmeldungen auf einer Stufe hoher Priorität umfaßt.

13. Vorrichtung nach Anspruch 10, 11 oder 12, wobei das besagte Netz ein Breitband-Datennetz ist, das Daten in Zellen überträgt, und das besagte gezielte

Übertragen von Meldungen hoher Priorität das Übertragen der besagten Meldungen hoher Priorität als Gruppen von Zellen hoher Priorität umfaßt.

14. Vorrichtung nach Anspruch 10, 11, 12 oder 13, wobei jeweiligen der besagten virtuellen Kanäle Übertragungsratenparameter zum Begrenzen einer Übertragungsrate aus besagten jeweiligen der besagten virtuellen Kanäle zugewiesen werden, und mit unter der Steuerung eines Programms wirkenden Prozeßmitteln zum Überwachen einer Übertragungsrate aus besagten jeweiligen der besagten virtuellen Kanäle.

15. Vorrichtung nach einem beliebigen der Ansprüche 10 bis 14, mit folgendem:

einem unter der Steuerung eines Programms wirkenden Prozessormittel, das auf den Empfang einer Anforderungsmeldung zur Übertragung aus einem virtuellen Kanal zum besagten Netz reagiert, wobei die besagte Anforderung mindestens einen angeforderten Bandbreitenparameter umfaßt, zum Bestimmen, ob der besagten Anforderung ohne Überladen des besagten Netzes genügt werden kann; und
einem unter der Steuerung eines Programms wirkenden Prozessormittel, das auf das besagte Mittel zum Bestimmen reagiert und bestimmt, daß der besagten Anforderung nicht ohne Überladen des besagten Netzes genügt werden kann, zum Übertragen zum besagten virtuellen Kanal einer Antwortmeldung mit mindestens einem Bandbreitenparameter für eine niedrigere Bandbreite als eine Bandbreite für besagten mindestens einen Bandbreitenparameter, der in der besagten Anforderungsmeldung empfangen worden ist.

16. Vorrichtung nach einem beliebigen der Ansprüche 10 bis 15, mit folgendem:

einem unter der Steuerung eines Programms wirkenden Prozessormittel, das auf den Empfang einer Anforderungsmeldung zur Übertragung aus einem virtuellen Kanal reagiert, wobei die besagte Anforderung mindestens einen angeforderten Bandbreitenparameter umfaßt, zum Bestimmen, ob der besagten Anforderung ohne Überladen des besagten Netzes genügt werden kann; und
einem unter der Steuerung eines Programms wirkenden Prozessormittel, das auf eine Bestimmung reagiert, daß der besagten Anforderung nicht ohne Überladen des besagten Netzes genügt werden kann, zum Übertragen einer Abweisungsantwortmeldung zum besagten virtuellen Kanal.

Revendications

1. Procédé d'étranglement de l'entrée dans un réseau de données (20) connecté par l'intermédiaire d'un commutateur d'entrée (4) à une pluralité de terminaux de données (1,2), chaque terminal desservant au moins un canal virtuel, ledit commutateur d'entrée ayant une capacité de desserte d'une charge de trafic de données maximale à partir desdits terminaux de données et à partir dudit réseau, comprenant les étapes de :

détection (400) dans ledit commutateur d'entrée dudit réseau de données qu'une charge soumise à partir desdits terminaux de données et à partir dudit réseau dépasse ladite charge de trafic de données maximale ; et

CARACTERISE PAR :

en réponse à ladite détection, la transmission (406) sélective (404) de messages de ralentissement (9) pour changer au moins un paramètre, ledit au moins un paramètre étant utilisé pour commander la vitesse de transmission des données sur un canal virtuel, dans un sens servant à réduire ladite vitesse de transmission vers ledit commutateur d'entrée dudit réseau à partir de certains desdits canaux virtuels ;

dans lequel la transmission sélective comprend la sélection de canaux virtuels dont le débit de données doit être réduit en considérant au moins un élément parmi la priorité (basse priorité préférée), la largeur de bande (haute largeur de bande préférée), et l'usage (canaux dépassant leur débit de données attribué à la largeur de bande préférés) de chaque canal virtuel candidat.

2. Procédé selon la revendication 1, dans lequel si, après l'écoulement d'un intervalle de temps, la charge soumise continue de dépasser ladite charge de trafic de données maximale, l'étape de transmission sélective de messages de ralentissement est répétée.

3. Procédé selon la revendication 1 ou 2, comprenant :

dans l'un desdits canaux virtuels, en réponse à la réception d'un message de ralentissement, la diminution d'une limite de vitesse de transmission de données de pointe sur ledit canal virtuel.

4. Procédé selon la revendication 3, dans lequel ledit réseau est un réseau de données à large bande, transmettant des données dans des cellules, et la-

dite étape de diminution comprend la diminution d'un certain nombre de cellules qui peuvent être transmises par unité de temps à partir dudit terminal.

5. Procédé selon la revendication 1, 2, 3 ou 4, dans lequel ledit réseau supporte un service de messagerie prioritaire, et ladite étape de transmission sélective comprend la transmission sélective de messages de ralentissement à un niveau de haute priorité.

6. Procédé selon l'une quelconque des revendications précédentes, dans lequel à certains desdits canaux virtuels sont attribués des paramètres de vitesse de transmission pour limiter une vitesse de transmission à partir desdits certains desdits canaux virtuels, et comprenant la surveillance d'une vitesse de transmission à partir desdits certains desdits canaux virtuels.

7. Procédé selon l'une quelconque des revendications précédentes, comprenant :

dans l'un desdits canaux virtuels, en réponse à la réception d'un message de ralentissement, la diminution d'une limite de vitesse moyenne de transmission de données par ledit canal virtuel dans lequel ladite limite est spécifiée en fournissant un paramètre de vitesse de drainage de compartiment de fuite.

8. Procédé selon l'une quelconque des revendications précédentes, comprenant les étapes de :

en réponse à la réception d'un message de demande de transmission depuis un canal virtuel vers ledit réseau, ladite demande comprenant au moins un paramètre de largeur de bande demandé, détermination si ladite demande peut être acceptée sans surcharger ledit réseau ; et en réponse à la détermination que ladite demande ne peut pas être acceptée sans surcharger ledit réseau, transmission audit canal virtuel d'un message de réponse comprenant au moins un paramètre de largeur de bande pour une largeur de bande inférieure à une largeur de bande pour ledit au moins un paramètre de largeur de bande reçu dans ledit message de demande.

9. Procédé selon l'une quelconque des revendications précédentes, comprenant les étapes de :

en réponse à la réception d'un message de demande de transmission depuis un canal virtuel, ladite demande comprenant au moins un paramètre de largeur de bande demandé, détermination si ladite demande peut être acceptée sans surcharger ledit réseau ; et
en réponse à la détermination que ladite demande ne peut pas être acceptée sans surcharger ledit réseau, transmission audit canal virtuel d'un message de réponse de rejet.

10. Dispositif dans un réseau de données (20) connecté par l'intermédiaire d'un commutateur d'entrée (4) à une pluralité de terminaux de données (1,2), chacun desservant au moins un canal virtuel, ledit commutateur d'entrée ayant une capacité de desserte d'une charge de trafic de données maximale à partir desdits terminaux de données et à partir dudit réseau, ledit dispositif servant à étrangler l'entrée dans le réseau et comprenant :

des moyens de traitement (5), fonctionnant sous la commande d'un programme, pour détecter (400) dans ledit commutateur d'entrée dudit réseau de données qu'une charge soumise à partir desdits terminaux de données et à partir dudit réseau dépasse ladite charge de trafic de données maximale ;

CARACTERISE PAR :

en réponse à ladite détection, lesdits moyens de traitement sous la commande d'un programme de transmission (406) sélective (404) de messages de ralentissement (9), pour changer au moins un paramètre, utilisé pour commander la vitesse de transmission des données sur un canal virtuel, dans un sens visant à réduire ladite vitesse de transmission, vers certains desdits canaux virtuels ;
dans lequel ladite transmission sélective comprend la sélection de canaux virtuels dont le débit de données doit être réduit en considérant au moins un élément parmi la priorité (basse priorité préférée), la largeur de bande (haute largeur de bande préférée), et l'usage (canaux dépassant leur débit de données attribué à la largeur de bande préférés) de chaque canal virtuel candidat.

11. Dispositif selon la revendication 10, dans lequel si, après l'écoulement d'un intervalle de temps, la charge soumise continue de dépasser ladite charge de trafic maximum, lesdits moyens de traitement sont placés sous la commande d'un programme de transmission sélective supplémentaire de messages de ralentissement.

12. Dispositif selon la revendication 10 ou 11, dans lequel ledit réseau supporte un service de messagerie prioritaire, et ladite transmission sélective comprend la transmission sélective de messages de ra-

lentissement à un niveau de priorité élevé.

13. Dispositif selon la revendication 10, 11 ou 12, dans lequel ledit réseau est un réseau de données à large bande, transmettant des données dans des cellules, et ladite transmission sélective de messages de haute priorité comprend la transmission desdits messages de haute priorité en tant que groupes de cellules de haute priorité.

14. Dispositif selon la revendication 10, 11, 12, ou 13, dans lequel à certains desdits canaux virtuels sont attribués des paramètres de vitesse de transmission pour limiter une vitesse de transmission à partir desdits certains desdits canaux virtuels, et comprenant des moyens de traitement, fonctionnant sous la commande d'un programme, pour surveiller une vitesse de transmission à partir desdits certains desdits canaux virtuels.

15. Dispositif selon l'une quelconque des revendications 10 à 14, comprenant :

des moyens de traitement, fonctionnant sous la commande d'un programme, sensibles à la réception d'un message de demande de transmission depuis un canal virtuel vers ledit réseau, ladite demande comprenant au moins un paramètre de largeur de bande demandé, pour déterminer si ladite demande peut être acceptée sans surcharger ledit réseau ; et
des moyens de traitement, fonctionnant sous la commande d'un programme, sensibles audit moyen de détermination, déterminant que ladite demande ne peut pas être acceptée sans surcharger ledit réseau, pour transmettre audit canal virtuel un message de réponse comprenant au moins un paramètre de largeur de bande pour une largeur de bande inférieure à une largeur de bande pour ledit au moins un paramètre de largeur de bande reçu dans ledit message de demande.

16. Dispositif selon l'une quelconque des revendications 10 à 15, comprenant :

des moyens de traitement, fonctionnant sous la commande d'un programme, sensibles à la réception d'un message de demande de transmission depuis un canal virtuel, ladite demande comprenant au moins un paramètre de largeur de bande demandé, pour déterminer si ladite demande peut être acceptée sans surcharger ledit réseau ; et
des moyens de traitement, fonctionnant sous la commande d'un programme, sensibles à une détermination que ladite demande ne peut pas être acceptée sans surcharger ledit réseau, pour transmettre audit canal virtuel un message de réponse de rejet.

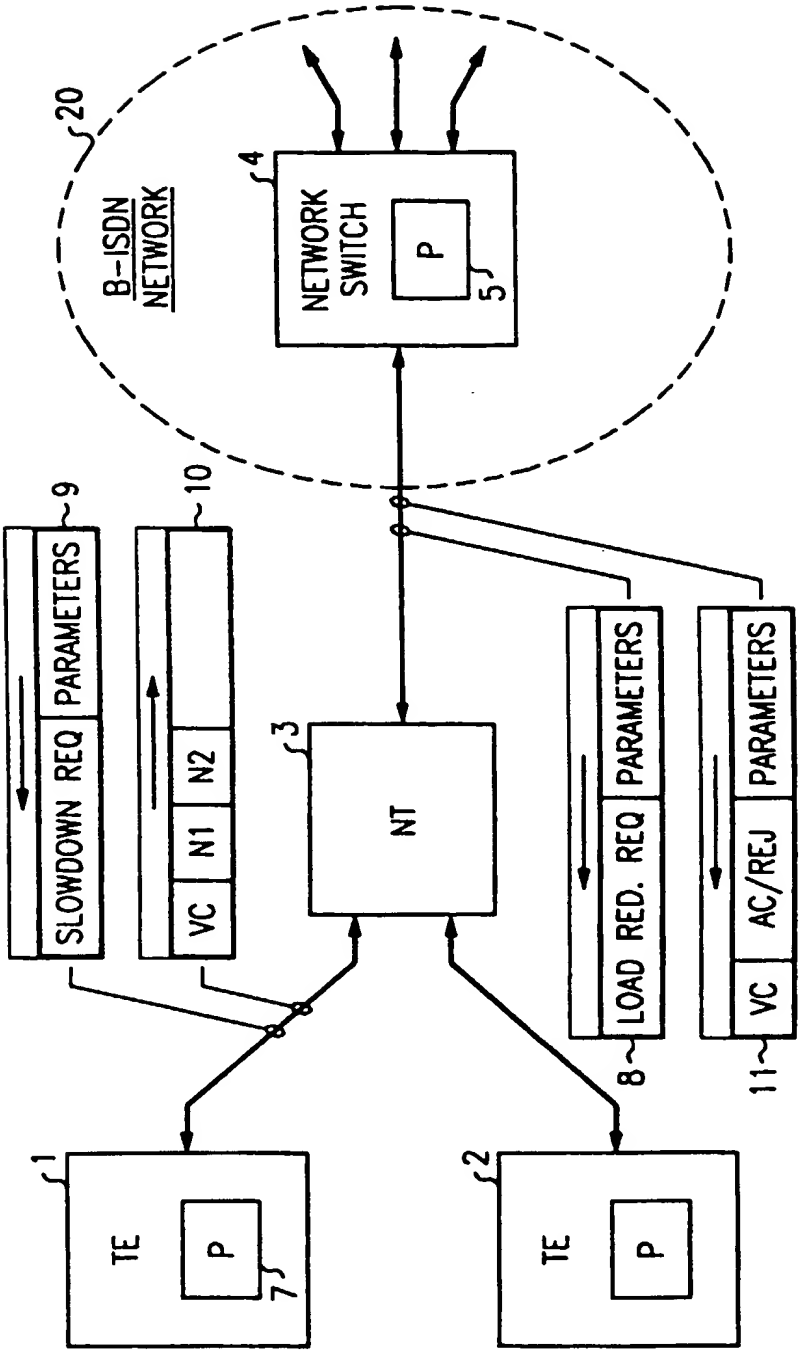

20
B-ISDN NETWORK
4
NETWORK SWITCH
P
5
9
SLOWDOWN REQ
PARAMETERS
10
VC
N1
N2
3
NT
LOAD RED. REQ
PARAMETERS
8
VC
AC/REJ
PARAMETERS
11
1
TE
P
7
2
TE
P

FIG. 1

FIG. 2

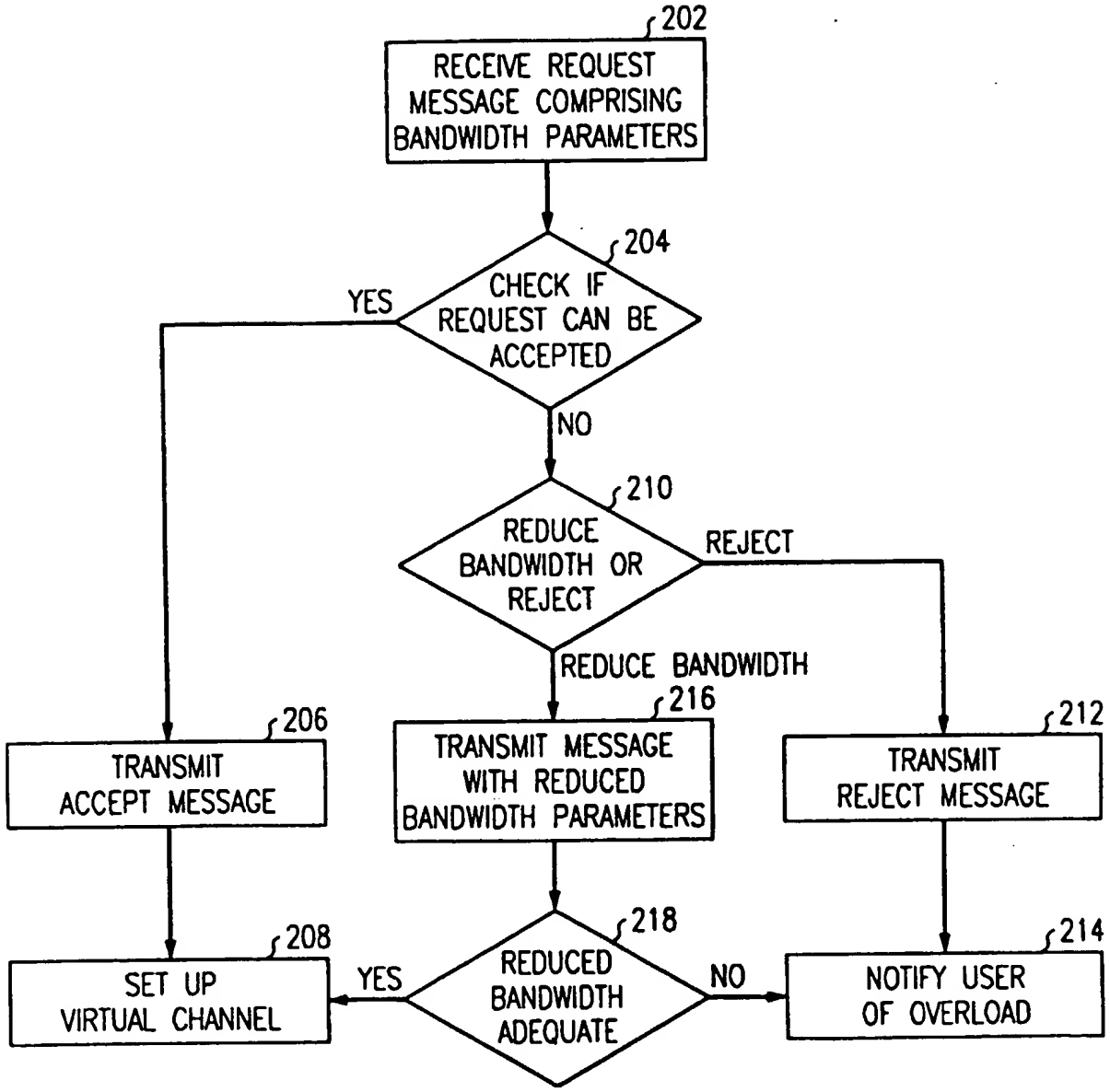

202
RECEIVE REQUEST MESSAGE COMPRISING BANDWIDTH PARAMETERS
204
CHECK IF REQUEST CAN BE ACCEPTED
YES
NO
210
REDUCE BANDWIDTH OR REJECT
REJECT
REDUCE BANDWIDTH
206
TRANSMIT ACCEPT MESSAGE
216
TRANSMIT MESSAGE WITH REDUCED BANDWIDTH PARAMETERS
212
TRANSMIT REJECT MESSAGE
208
SET UP VIRTUAL CHANNEL
YES
218
REDUCED BANDWIDTH ADEQUATE
NO
214
NOTIFY USER OF OVERLOAD

FIG. 3

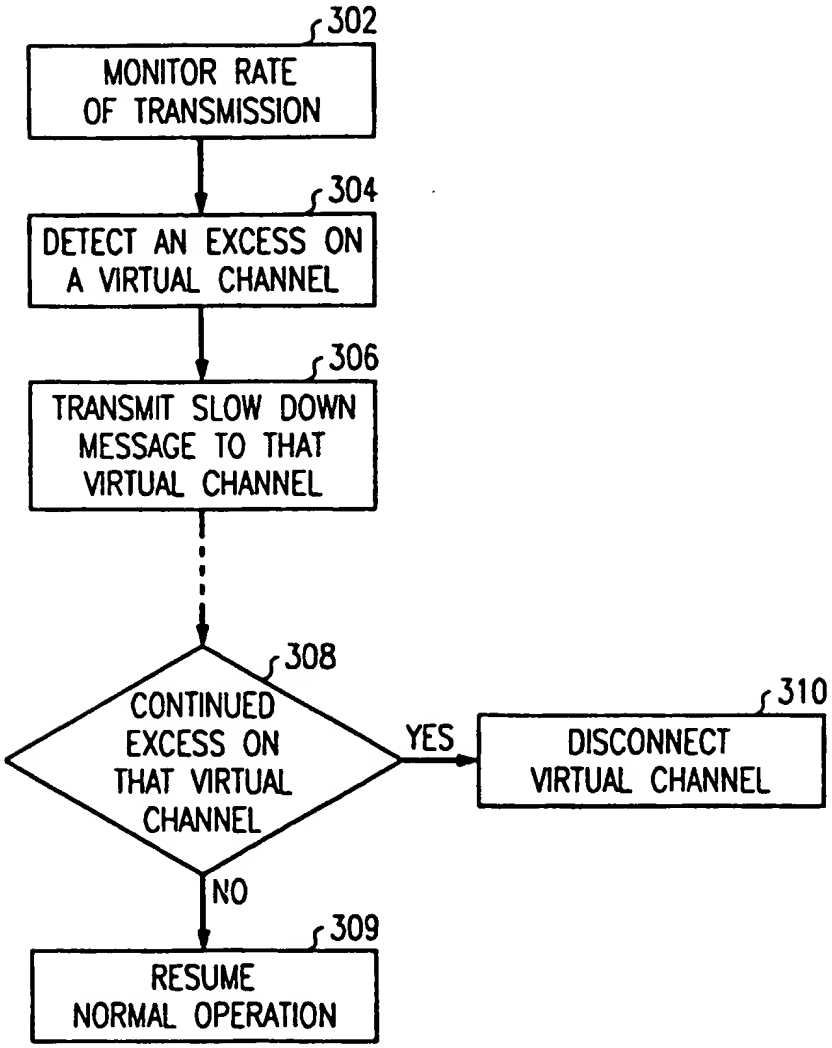
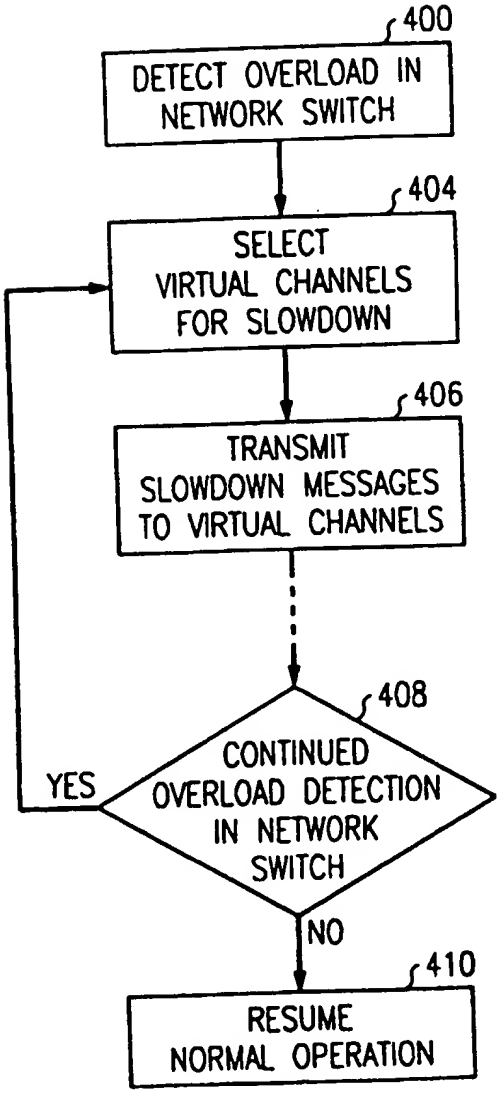

302
MONITOR RATE OF TRANSMISSION
304
DETECT AN EXCESS ON A VIRTUAL CHANNEL
306
TRANSMIT SLOW DOWN MESSAGE TO THAT VIRTUAL CHANNEL
308
CONTINUED EXCESS ON THAT VIRTUAL CHANNEL
YES
310
DISCONNECT VIRTUAL CHANNEL
NO
309
RESUME NORMAL OPERATION

FIG. 4


400
DETECT OVERLOAD IN NETWORK SWITCH
404
SELECT VIRTUAL CHANNELS FOR SLOWDOWN
406
TRANSMIT SLOWDOWN MESSAGES TO VIRTUAL CHANNELS
408
CONTINUED OVERLOAD DETECTION IN NETWORK SWITCH
YES
NO
410
RESUME NORMAL OPERATION